

ARMY AFTER NEXT: END OF THE LINE FOR FIELD ARTILLERY STANDARD TACTICAL MISSIONS?

**A MONOGRAPH
BY
Major Richard S. Richardson
Field Artillery**

**School of Advanced Military Studies
United States Army Command and General Staff
College
Fort Leavenworth, Kansas**

First Term AY 98-99

Approved for Public Release Distribution is Unlimited

DTIC QUALITY INSPECTED 2

19990804 083

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)

2. REPORT DATE

17 December 1998

3. REPORT TYPE AND DATES COVERED

Monograph

4. TITLE AND SUBTITLE

Army After Next: End of the Line for Field Artillery
Standard Tactical Missions?

5. FUNDING NUMBERS

6. AUTHOR(S)

Major Richard Scott Richardson

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

School of Advanced Military Studies
Command and General Staff College
Fort Leavenworth, Kansas 66027

8. PERFORMING ORGANIZATION
REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Command and General Staff College
Fort Leavenworth, Kansas 66027

10. SPONSORING / MONITORING
AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE
DISTRIBUTION UNLIMITED.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

SEE ATTACHED

14. SUBJECT TERMS

Standard Tactical Missions, Field Artillery, Army after Next

15. NUMBER OF PAGES

58

16. PRICE CODE

17. SECURITY CLASSIFICATION
OF REPORT

UNCLASSIFIED

18. SECURITY CLASSIFICATION OF THIS
PAGE

UNCLASSIFIED

19. SECURITY CLASSIFICATION
OF ABSTRACT

UNCLASSIFIED

20. LIMITATION OF ABSTRACT

UNLIMITED

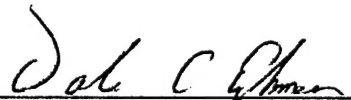
SCHOOL OF ADVANCED MILITARY STUDIES

MONOGRAPH APPROVAL

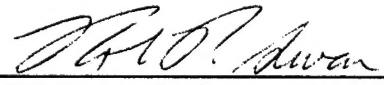
Major Richard S. Richardson

Title of Monograph: *Army After Next: End of the Line for Field Artillery Standard
Tactical Missions?*

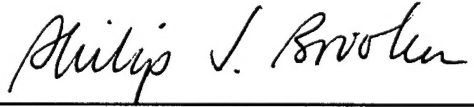
Approved by:



LTC Dale C. Eikmeier, MA Monograph Director



LTC Robin P. Swan, MMAS Director, School of Advanced
Military Studies



Philip J. Brookes, Ph.D. Director, Graduate Degree
Program

Accepted this 16th Day of December 1998

Abstract

Army After Next: End of the Line for Field Artillery Standard Tactical Missions?
by Major Rick S. Richardson, USA, 42 pages.

The purpose of this monograph is to examine the relevance of current doctrine for organizing artillery for combat within the context of the changes anticipated by 2025 in the Army After Next. The primary research question is: Will Army After Next technology require a change to the Field Artillery Standard Tactical Missions as the means to organize for combat? This Monograph concludes that a change will be required. By 2025, technological advancements will invalidate the basis on which the current organization for combat doctrine was developed. Significant improvements in munitions and control capabilities will require fundamental reengineering of current doctrine. While it is possible to apply the doctrine of the 90's in 2025 and make it work, doing so would be foolish for this would fail to exploit the capabilities inherent in the forthcoming advanced technology.

Standard Tactical Missions are not appropriate for interdependent artillery and maneuver operations. With the anticipated capabilities and combat doctrine changes for the Army After Next, the current system of artillery organization fails to support interdependent fires. The purpose of current doctrine is designed to organize indirect fire support based upon the support relationship to maneuver. This doctrine lacks an adequate mechanism to assign indirect fires assets a mission separate from maneuver elements. The purpose of current doctrine is not retained in the Army After Next environment so current doctrine must change.

Army After Next indirect fires structured using Standard Tactical Missions will not effectively support distributed operations. Significant changes in the fires model will change the conditions that Standard Tactical Missions were developed for. These changes include increased battlefield dispersion, weapons capabilities, command and control. In addition, the transition to effects based doctrine will replace the traditional "weapon-centric" fires doctrine. Standard Tactical Missions will not be relevant in an environment where resources are allocated by effects instead of by platform.

Army After Next fires organized using Standard Tactical Missions will not be responsive to the total forces needs. This organizational model is not simultaneously responsive to both the force commander and maneuver subordinate units. Besides limited responsiveness, Standard Tactical Missions prevent utilization of firing platforms at their maximum efficiency because this structure places assets in a hierarchy which "stovepipes" fires requests and coordination. The current organizational structure limits use of fires assets at maximum capacity because of practical difficulties in providing support to units outside of the established hierarchy.

Table of Contents

	<u>Page</u>
Chapter 1 -- Looking Ahead	1
• Introduction	
• Principle Research Question & Conclusion	
• Statement of the Problem	
• Importance of Study	
Chapter 2 -- Examination of Current Doctrine	5
• Organization for Combat	
• Command Relationships	
• Field Artillery Standard Tactical Missions	
• Fundamentals of Organizing Artillery for Combat	
Chapter 3 -- Future Capabilities: Army After Next 2025	13
• Tactical Doctrine for Army After Next	
• Weapon Systems 2025	
• Sensors 2025	
• Command, Control, Communications 2025	
Chapter 4 -- Analysis and Evaluation of Doctrine	23
• Interdependent Fires and Maneuver	
• Distributed Operations	
• Responsiveness & Efficiency	
Chapter 5 -- Conclusion	39
• Summary of the Findings	
• Areas of Further Study	

Appendix	43
-----------------	-----------

A. Army After Next Battle Force Organization

Endnotes	44
-----------------	-----------

Bibliography	49
---------------------	-----------

Chapter 1

Looking Ahead

“Warfare is the greatest affair of state, the basis of life and death, the way to survival or extinction. It must be thoroughly pondered and analyzed.”¹

Sun Tzu

Introduction

It is clear that technology will make a greater impact on the future than ever before. While not a panacea for the current limitations of fire support, the impact of technology deserves careful study. Advanced technology may break the fire support model that has served the Army well since World War II. New communications, control, and delivery means may require an elemental shift in how we command and control our fire support system.

The challenge is to foresee the capabilities we will have in the future, compare these to our current doctrine, and then predict a path for doctrinal anticipation and adaptation. This monograph sets an azimuth for fire support doctrine development with the belief that it is better to have a doctrine waiting for a technology, then to have a technology waiting for doctrine to catch up.

The cost of failing to look ahead and reflect on the coming changes is high. “Failure to understand and adapt could lead today’s militaries into premature obsolescence and greatly increase the risks that such forces will be incapable of effective operations against forces with high technology.”²

The principal question that this monograph answers is: Will Army After Next technology require a change to the Field Artillery Standard Tactical Missions as the means to organize for combat? Based on research and analysis of current doctrine and

Army After Next capabilities, the answer is yes. By 2025, technological advancements will invalidate the basis on which the current fire support organization for combat doctrine was developed. Significant improvements in munitions and control capabilities will require fundamental reengineering of current doctrine. While it is possible to apply the doctrine of the 1990's in 2025 and make it work, doing so would be foolish for this would fail to exploit the capabilities inherent in the forthcoming advanced technology.

This research question is certainly far sighted but relevant today give the mission of the Army After Next program to

Conduct broad studies of warfare to about the year 2025 to frame issues vital to the development of the US Army after about 2010 and to provide those issues to the senior Army leadership in a format suitable for integration into Training and Doctrine Command development programs.³

The Army After Next builds on the Force XXI concepts currently being implemented at Fort Hood. The Army After Next will springboard from the advances made by the Force XXI program, and continue to exploit Force XXI's information dominance theme. The Army After Next will expand this information, while at the same time fielding new equipment to replace the equipment purchased during the defense build-up of the 80's. The end result will be a future force that forges a new marriage between Force XXI's battlefield knowledge and mental agility with unprecedented physical speed and agility.⁴

Predicting the future is always risky, but necessary if the Army is to be effective in tomorrow's environment. Fire support is one of the combat functions that is most profoundly affected by technological advances. The exponential efficiencies gained by technological enablers will require a fundamental shift in the doctrine of how we provide fires.

The Army must evaluate long-standing fire support doctrine and tactics, techniques, and procedures to determine their continued utility in the face of the changing environment. Because of the pace of change and growing number of different threats there is little room for error.

Today, firing platforms must be positioned close to supporting units because of limitations on range, communications, and span of control. The hierarchical command and control structure, limited weapon range, rate of fire, and difficulty making rapid changes to sensor to shooter links limit the flexibility of these platforms to fire outside of pre-designated zones of fire.

Fire support doctrine has long emphasized fire control via standard tactical missions that align field artillery units with supported maneuver units. Delivery platforms are organized for combat by assigning standard tactical missions, such as Direct Support, or Reinforcing, which links sensors to shooter for each major operation. These relationships compartmentalize fires into an organization that limits rapid adaptation to changing requirements.

Fire control within this organizational model is carried out via a series of layered nodes to plan and execute fires. Fires lack responsiveness because the hierarchical nature of the system adds communications and decision-making overhead that delays processing time. This hierarchy also funnels communications in sequential lines, which limits the ability to rapidly mass fires across organizational bounds.

The structure this monograph uses to explore these issues and answer the research question consists of four major parts. Chapter 2 explains the current doctrine for organizing artillery units for combat. This information is critical as a point of departure

to understand the current environment. Chapter 3 examines how this environment will change with the introduction of new technology and operations doctrine for the Army After Next of 2025. Chapter 4 analyzes and evaluates the continued applicability of the Standard Tactical Mission given the enhanced capabilities available by 2025 and the expected environmental changes. This analysis is structured around the areas of interdependent fires and maneuver, distributed operations, responsiveness, and efficiency. Chapter 5 states the summary of the findings and highlights areas of further study.

This monograph uses the following criteria to evaluate the suitability of current doctrine in the technological environment of 2025.

- Is the Standard Tactical Mission appropriate for interdependent artillery and maneuver Operations?
- Can Army After next fire support structured using Standard Tactical Missions effectively support distributed operations?
- Is Army After Next fire support structured using Standard Tactical Missions responsive to requesting unit's needs or do Standard Tactical Missions handicap fires?
- Do Standard Tactical Missions prevent utilization of firing platforms at their maximum efficiency?

Chapter 2

Examination of Current Doctrine

The mission of field artillery is to destroy, neutralize, or suppress the enemy by cannon, rocket, and missile fire and to help integrate all fire support assets into combined arms operations.⁵

FM 6-20, Fire Support in the Airland Battle

Organization for Combat

It is important to understand the current doctrinal model as a point of departure when analyzing the impact of changing tactical doctrine and technology. This monograph uses current doctrine as a springboard to examine possible future doctrine for the Army After Next.

Field artillery is organized for combat to provide responsive and effective field artillery fires and to coordinate all fire support. To accomplish this, the force commander or his authorized representative (normally the Fire Support Coordinator) assigns tactical missions to field artillery units and places them in a tactical organization.⁶

Command and control relationships are established through two step process referred to as organization for combat. First, each field artillery unit is given a command relationship to a tactical unit, such as organic, assigned, attached, or operational control. Next, each field artillery unit is assigned a tactical mission, such as direct support, reinforcing, general support reinforcing, or general support.⁷

The consequence of these command relationships and tactical missions is the overall structure of the fire support system. This structure dictates the hierarchical organization of target acquisition assets, tactical fire direction channels, and fire support delivery

channels. In essence, this organization for combat lines up each field artillery unit with a supported maneuver unit.

Field artillery is organized at corps, division, and brigade with a specific command and control structure that enables the field artillery commander to accomplish his mission. Fire direction centers at Field Artillery battalions and brigades establish communications links with supported combat units and target acquisition assets in accordance with defined support relationships.

Command Relationships

Each field artillery unit is assigned a command relationship with a tactical unit. There are four command relationships specified in Field Manual 6-20, Fire Support in the Airland Battle.

1. Organic.⁸ Those units that are an integral part of a military organization and are found in this organization's Table of Organization and Equipment. An example of an organic command relationship is the howitzer battery that is organic to a Cavalry Squadron within an Armored Cavalry Regiment.
2. Assigned.⁹ Those units that have been assigned to an organization on a fairly permanent basis. This type of command relationship is established at the Department of the Army level and is part of the strategic tailoring of major units in the Army. An example of an assigned command relationship is the number and type of Field Artillery battalions assigned to a Corps.
3. Attached.¹⁰ Those units that have been assigned to an organization on a relatively temporary basis as part of the maneuver commander's tactical tailoring of his force. This may be done at any level. Attachment allows the receiving commander to assign tactical

tasks, change the attached unit's organization, however the receiving commander must provide administrative and logistical support. An example of an attached command relationship would be the attachment of Corps Field Artillery battalions to a Field Artillery Brigade headquarters, thus forming a Field Artillery Brigade.

4. Operational Control (OPCON).¹¹ Those units that have been placed under the Operational Control of another unit have the same responsibilities as in attachment except that the gaining commander has no responsibility for administrative or logistical support of the OPCON unit. Operational control does not, in and of itself, include authoritative direction for logistics or matters of administration, discipline, internal organization, or unit training.¹² Additionally, the gaining commander cannot tactically tailor the unit. This command relationship is frequently used between maneuver units; however, it is rarely used between maneuver units and field artillery. An example of a situation where artillery might be under operational control is when a Field Artillery Brigade is attached to an Armored Cavalry Regiment during a covering force mission. In this situation, the howitzer batteries organic to the Armored Cavalry Squadrons are typically placed under the operational control of the Field Artillery battalions belonging to the Field Artillery Brigade. This organization change is made to facilitate centralized command and control of all of the field artillery units within the command.

Field Artillery Standard Tactical Missions

Once command relationships are established, each field artillery unit is assigned a tactical mission.¹³ Tactical missions describe in detail the fire support responsibilities of a field artillery unit and establish the fire support relationship with a maneuver unit or another field artillery unit. Tactical missions do not affect the organizational structure or

the command relationships that result from that structure. Tactical missions include the following.

1. Direct Support. This is the normal mission for a field artillery unit providing close and continuous fire support for a specific maneuver unit. A field artillery battalion with this mission is primarily focused on supporting only that brigade. Fires are planned and coordinated to support the maneuver unit and the battalion is positioned to provide support in the maneuver brigade's zone of action. Typically, the same field artillery battalion habitually supports the same maneuver brigade to enhance coordination during training and operations. The essential feature of the direct support mission is a one-to-one relationship between the field artillery battalion and the supported maneuver force.¹⁴ Normally, one direct support battalion is assigned to each committed maneuver brigade.¹⁵ Direct support is the most decentralized standard tactical mission (see figure 1).

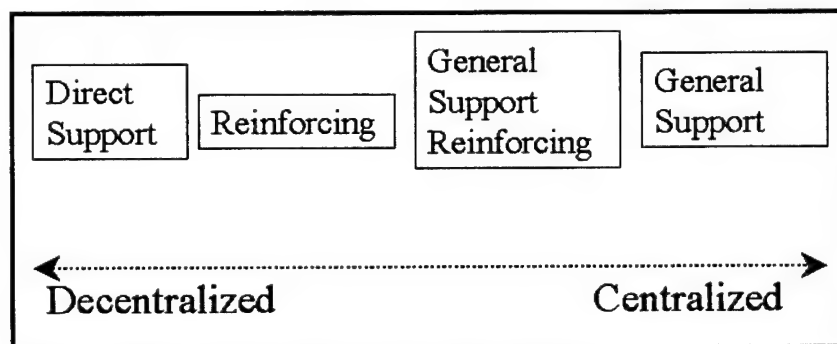


Figure 1. Field Artillery Standard Tactical Missions

2. Reinforcing. Reinforcing is a tactical mission that directs one field artillery battalion to augment the fires of another field artillery battalion.¹⁶ Typically, a battalion with the reinforcing mission can only reinforce one FA battalion. However, multiple field artillery battalions can reinforce the supported battalion. Current organization and control capabilities do not support a battalion reinforcing multiple battalions.

Reinforcing missions are usually used to increase the field artillery support to a maneuver unit, without attachment or having multiple direct support battalions.

3. General Support. A field artillery battalion assigned the mission of general support supports the force as a whole and stays under the control of the force artillery headquarters.¹⁷ This mission centralizes control under the overall force commander at the expense of responsiveness to the immediate needs of lower maneuver echelons. This tactical mission is the most centralized.

4. General Support Reinforcing. This mission combines the responsibilities of the Reinforcing and General Support mission. This mission requires the field artillery battalion to first furnish artillery fires for the force as a whole and then to reinforce the fires of another field artillery unit as a second priority. The General Support Reinforcing mission is the most flexible mission, providing the commander with maximum flexibility for a variety of tactical situations.¹⁸

Figure 2 shows the seven inherent responsibilities of each field artillery standard tactical mission.

AN FA UNIT WITH A MISSION OF--	DIRECT SUPPORT	REINFORCING	GENERAL SUPPORT REINFORCING	GENERAL SUPPORT
1. Answers calls for fire in priority from--	1. Supported Unit 2. Own observers ¹ 3. Force FA HQ	1. Reinforced FA 2. Own observers ¹ 3. Force FA HQ	1. Force FA HQ 2. Reinforced unit 3. Own observers ¹	1. Force FA HQ 2. Own Observers ¹
2. Has as its zone of fire--	Zone of action of supported unit	Zone of fire of reinforced FA	Zone of action of supported unit to include zone of fire of reinforced FA unit	Zone of action of supported unit

3. Furnishes fire support team--	Provides temporary replacements for casualty losses as required	No requirement	No requirement	No requirement
4. Furnishes liaison officer--	No requirement	To reinforced FA unit HQ	To reinforced FA unit HQ	No requirement
5. Establishes communications with--	Company FSOs, FSOs, and supported maneuver HQ	Reinforced FA unit HQ	Reinforced FA unit HQ	No requirement
6. Is positioned by-	DS FA unit commander or as ordered by force FA HQ	Reinforced FA unit or as ordered by force FA HQ	Force FA HQ or reinforced FA unit if approved by force FA HQ	Force FA HQ
7. Has its fires planned by--	Develops own fire plans	Reinforced FA unit HQ	Force FA HQ	Force FA HQ
¹ Includes all target acquisition means not deployed with supported unit (radar, aerial observers, survey parties, etc.) ² A fire support section for each maneuver brigade/battalion/cavalry squadron and one fire support team with each maneuver company/ground cavalry troop are trained and deployed by the FA unit authorized these assets by Toe. After deployment, fire support section and teams remain with the supported maneuver unit throughout the conflict.				

Figure 2. Inherent Responsibilities of Field Artillery Missions¹⁹

Fundamentals of Organizing Artillery for Combat

Field Manual 6-20, Fire Support in the Airland Battle specifies five fundamentals to be considered when organizing field artillery for combat.

1. Adequate field artillery support for committed combat units. The minimum adequate support for committed units is one field artillery battalion in direct support of each maneuver brigade. Field artillery support is most responsive to committed maneuver elements when it is placed in Direct Support.²⁰ Additional responsiveness is provided through the assignment of Reinforcing and General Support Reinforcing missions.

2. Weight to the main attack in offense or most vulnerable area in defense.

Maneuver units can be weighted by assigning field artillery battalions with a reinforcing or general support reinforcing missions to provide additional fires. In addition, Commanders can position and assign zones of fire to General Support field artillery battalions to focus their fires on the zone of the main attack or the sector of the most vulnerable area or main effort.²¹

3. Facilitate future operations. According to FM 6-20, Fire Support in the Airland Battle facilitating future operations “is essential to ensure success in the face of unforeseen events and to ensure smooth transition from one phase of an operation to another.” The assignment of on order missions allows a unit to anticipate and plan for future operations.²²

4. Immediately available field artillery support with which the commander can influence the action. Doctrine advises that “the force FA commander should retain some artillery with which the force commander can influence the action. This is done by assigning GS [General Support] or GSR [General Support Reinforcing] missions to artillery units, making them responsive to the force commander.”

5. Maximum feasible centralized control. FM 6-20, Fire Support in the Airland Battle states “field artillery is most effective when control is centralized at the highest force level consistent with the fire support capabilities and requirements of the overall mission.” Centralized control has long been critical to achieving the most productivity out of available assets. Centralized control allows agility to rapidly shift the bulk of fires to the area with the greatest need. In addition, centralized control facilitates massing fires from multiple delivery platforms. Typically, centralized control is preferred in defensive

situations where it is difficult to accurately pick where and when the enemy will strike. In offensive situations, the reverse is true.²³

These fundamentals can be achieved primarily through the assignment of tactical missions; however, allocation of ammunition, and positioning of artillery can also comply with the fundamentals. For example, the commander can weight the main attack's supporting artillery by allocating more ammunition to those units. In addition, the commander can position some of his General Support artillery battalions where they can range the main effort's zone of action.²⁴

Conclusion

The current field artillery organization for combat doctrine is adequate given current maneuver doctrine, organization, and equipment. If the standard tactical mission does not meet the commander's requirements, then the commander may assign a non-standard tactical mission. The commander may amplify, limit, or change one or more of the seven inherent responsibilities or specify additional directives for situations outside of the responsibilities stated in figure 2.²⁵

Chapter 3

Future Capabilities: Army After Next 2025

“Like the Second Industrial Revolution at the turn of the last century, the rapidly unfolding Information Age has produced diverse primary, supporting, and enabling technologies requiring investment, testing, and evaluation.”²⁶

Antulio J. Echevarria II

Tactical Doctrine for Army After Next

Future war experts are predicting that Army After Next warfare will be characterized by the projection of more lethal and mobile forces, rapid maneuver in non-linear and distributed operations and the explosion of information technologies.²⁷ Modern weaponry, brilliant munitions, and the high cost of fielding large armies will contribute to the movement towards widely dispersed and non-contiguous forces on future battlefields.²⁸ The focus will be on concentration of effects, not forces. Combat operations will be characterized by information operations, increased mobility, lethality and the ability to engage a vast number of targets over larger areas of the battlespace than ever before. According to Joint Vision 2010, this more lethal battlespace “will increase the importance of stealth, mobility, dispersion, and pursuit of a higher operational tempo.”²⁹

Future warfare will take place on an expanded battlespace that extends beyond the traditional physical dimensions of width, depth, and height. This new battlespace will include expansion of the realms of the Electro-magnetic spectrum, the human dimension, and time.³⁰

Future tactical doctrine will be characterized by synchronized attacks throughout the battlespace on targets to first set the conditions for enemy defeat by initially enhancing

their vulnerability then follow up attacks at critical times and places.³¹ Such decisive attacks will require great precision.

Three emerging capabilities will enable tactical precision. First, digitization will provide soldiers and leaders at each echelon the information required for making informed decisions. Second, modern tactical sensors linked to synthesis teams will fuse combat data and information into useful knowledge, providing comprehensive situational awareness. Third, simulations will enable army elements to be tailored based on emerging situation/crisis, plan, wargame and rehearse those operations resulting in enhanced precision in execution.³²

Dramatic increased precision, range, and lethality of munitions will cause fires to rise in importance to be “co-equal” with maneuver forces. No longer will fires be limited to “fire support.” Instead, indirect fires will have the capability to accomplish battlefield tasks independent or interdependent of maneuver forces.

Besides the “ascendance of fires”, another important change in the Army After Next model is the vertical shift. Figure 3 shows how the Army After Next will shift from a linear model to a vertical model. To achieve the degree of knowledge dominance and operational speed envisioned for 2025, the Army must expand from its traditional linear, two-dimensional orientation to fully embrace a vertical, three-dimensional orientation.³³ Advanced airframes will enable the tactical lift of mechanized forces that will allow mechanized commanders to use the ground tactically for cover and concealment without suffering degradation in mobility.

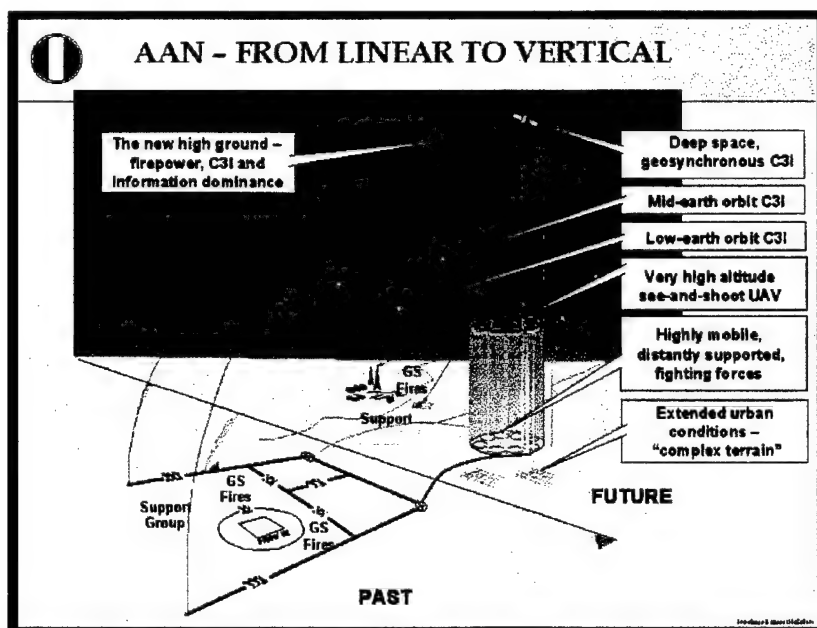


Figure 3. Vertical Shift

Weapon Systems 2025

Platforms

The Crusader system will replace the M109 Self Propelled-Howitzer system for mechanized forces beginning full rate production in 2005.³⁴ Crusader will serve as the primary mechanized fire support weapon during the Force XXI year and will be the legacy fire support system for the Army After Next. Crusader will be the first U.S. Army weapon designed from the ground up for digital communications and fire control. Besides firing faster and farther than the M109 series howitzer, Crusader will provide multiple round simultaneous impact capability. To accomplish this, onboard computers calculate firing solutions for each projectile allowing each Crusader to fire up to eight rounds on different trajectories so that all rounds land at the exact same time on the same target.³⁵

The Multiple Launch Rocket System (MLRS) platform is expected to continue service into the Army After Next timeframe. This system fires both free flight and

guided rockets, and the Army Tactical Missile System. This system will receive an upgrade in the year 2000-2007 time frame to the M270A1 configuration. This upgrade includes the Improved Fire Control System that will add additional capacity to accommodate complex munitions and modern computer electronics, including video display, onboard navigation with global positioning system technology, architecture for ultra-fast signal processing and advanced mission software. Another upgrade to the launcher's mechanical system will reduce the time to aim the launcher from 93 to 16 seconds and reduce the reloading time.³⁶

Advanced Technology Light Artillery System (ATLAS) is a towed howitzer system in development to provide indirect fire support to light contingency forces. ATLAS will incorporate advanced technologies into a howitzer that is rapidly deployable without sacrificing range, accuracy, reliability, or deployability. Most important, ATLAS will allow rapid movement of the weapon, crew, and ammunition package across the battlefield by light helicopters such as the UH-60.³⁷

High-mobility Multipurpose Artillery Rocket System (HIMARS) is a lightweight, wheeled rocket system in development to provide rocket and missile fires for rapid deployment forces. The U.S. Army will field the High-mobility Multipurpose Artillery Rocket System beginning in 2007. HIMARS will be C-130 transportable and will be capable of firing the same munitions as the Multiple Launch Rocket System launcher. However, unlike the MLRS, the HIMARS will only have one weapons bay.³⁸

One potential future platform is the Wide Area Support Platform (WASP), also labeled as the Advanced Fire Support System (AFSS), which presents a totally new concept for a fire support weapon. The Wide Area Support Platform is a crew-less

remotely operated and containerized weapons platform. This self-contained system can receive firing data from remote sensors via a networked communications link to provide fires on an area support basis.³⁹ The Wide Area Support Platform can be pre-positioned or dropped anywhere on the battlefield to provide deliver of fires on an area support basis.

By 2025, field artillery platforms are expected to move to the new "high ground." Both space based and high-altitude Unmanned Aerial Vehicles will provide fires from above the traditional battlespace. These platforms are expected to provide long endurance fire support to the battlefield commander. According to Colonel Robert Killebrew, deputy director of the Army After Next Project,

In cooperation with the U.S. Air Force, the Army could develop ultrahigh-altitude, long endurance Unmanned Aerial Vehicles with sufficient payload for data links, intelligence platforms and a look-down, shoot-down capability for precise fires in support of ground units. Flying at the edge of space for extended period, these weapons and communications platforms could lift from ground maneuver units the weight of communications, intelligence and all or a portion of indirect fire logistics.⁴⁰

The Army After Next may see the replacement of the ATLAS, HIMARS, MLRS, and Crusader by a medium weight common platform. This platform may be a hybrid system with both rocket and cannon capacities. This system is expected to have a munitions range greater than 50 kilometers, and have an operating range of 800-1500 kilometers. This desired system will have the capability to operate for thirty days or 1500 kilometers before power re-supply. In addition, this system will have a weight of 15-20 tons and be ready for employment within 15 minutes of aircraft offload from an advanced battlefield transport vehicle.⁴¹ This weapon system will be able to deliver the following fires: suppression, destruction, long range, close combat protection, and obscuration.⁴²

Munitions

There are three overarching trends for 2025 munitions. First, these munitions will have unprecedented precision. Improved position navigation technologies such as third generation inertial gyros, second-generation global navigation systems, and micro Electro-mechanical systems will give these munitions incredible precision. Besides precision guidance and target definition, many of these munitions will be capable of in-flight re-tasking.⁴³ Many of these systems will have the capability to automatically seek, identify, discriminate and autonomously attack targets within specified parameters. Munitions may also communicate with each other and provide target damage and battlefield condition assessment.⁴⁴

A second munition trend is the ability to loiter. Loitering is the ability to stay over a specified area scanning for targets or awaiting instructions for extended time periods. Using new propulsion and gliding technologies, many future munitions can be launched without having to be employed immediately.

One example of the Army After Next precision and loiter capability is the Brilliant Anti-armor Sub-munition (BAT) Pre-planned Product Improvement (P3I). The Brilliant Anti-armor Sub-munition of 2025 will employ acoustic, millimeter wave radar, and imaging infrared seekers to autonomously locate, attack, and destroy its targets.⁴⁵ The BAT P3I is designed for use against moving or stationary tanks and other vehicles. Each Army Tactical Missile will deliver six BAT P3I sub-munitions per missile.⁴⁶

The third munitions trend is the emphasis on improved munitions capabilities to achieve effects, rather than a focus on improved platform capabilities. In other words, future munitions development will be based upon required effects then develop platforms

for these munitions. In the past, the effectiveness of artillery has largely been a function of the caliber, range, volume of fire, and accuracy of the shooting platform's location. Given the dramatic increases in rates of fire, ranges, and precision, the burden of effectiveness will begin to shift to the munition itself.

Sensors 2025

A multitude of new sensor systems will bring U.S. forces knowledge dominance on the Army After Next battlefield. These sensor systems will be connected electronically to an Unmanned Aerial Vehicle based communications network operating within an umbrella of space-based communications systems.⁴⁷ These systems will include satellite-based sensors, munitions based battle damage assessment sensors, and Unmanned Aerial Vehicle sensor platforms.

Unmanned Aerial Vehicle platforms are expected to grow substantially in both numbers employed and capabilities. Long duration Unmanned Aerial Vehicles such as Darkstar will provide long range, long duration surveillance. Evolving sensors on these platforms such as millimeter wave radar, synthetic aperture radar, thermal, acoustic, and infrared will provide unprecedented surveillance capability.⁴⁸

Command, Control, Communications 2025

Critical to most of the Army After Next enhancements is the ability to move large amounts of digitized information. In addition, the ability to process incredible amounts of data into usable knowledge is essential to maintaining knowledge dominance. These capabilities together will provide unprecedented advances in the ability to command and control units in the Army After Next. It is expected that the traditional limitations of

span of control will be lifted given these new capabilities. More powerful, robust, and reliable communications systems will support extended ranges and increasing centralized control.

Communications

Results from the Winter Wargame held at Fort Leavenworth indicate that low, mid, and high-altitude Unmanned Aerial Vehicles will become increasingly important as a communications relay system to supplement space systems.⁴⁹ These Unmanned Aerial Vehicle based systems will provide enhanced line-of-site communications capabilities that make up for the traditional line-of-site weakness of ground based tactical communications transmitters.

Military space-based communications systems continue to improve, however, in the next twenty years the commercial space-based communications capability is going to increase exponentially. For example, between 2000 and 2004, nine new commercial satellite-based communications systems will be deployed utilizing a total of 730 satellites.⁵⁰ This capability will provide a complementary and redundant satellite communications capability to the military. Most important, these commercial satellites will significantly increase the bandwidth available to the tactical commander.

Increasing the bandwidth, or throughput of information, will allow increased use of multimedia in the form of moving pictures and sound to communicate ideas to other units within the battlespace. Battlefield video teleconferencing will improve the ability of humans to communicate by providing real-time visual interaction.

Command & Control

Advanced microprocessors and software are expected to continue to improve at an incredible rate. According to the Department of Defense Military Critical Technologies Study, "High-performance computing is an enabling technology for modern tactical and strategic warfare. It is the principal technological force multiplier that gives U.S. forces their superior ability to detect, localize, and effectively engage enemy forces."⁵¹

Processing data at higher rates is important to achieve real-time performance and more accurate management of situational awareness, target assignment and tracking. In addition, advances in these areas will provide improved tools for terrain analysis, battlefield visualization, and decision making. These tools will "fuse information from multiple sources while rapid generation of high-fidelity databases will enable the commander to visualize current and future operations."⁵²

Enhanced decision support tools will minimize tactical fire planning times. These computer assisted software tools will consolidate data and produce analytical products to assist the commander and staff when planning operations.

Advanced man-machine interface technology such as touch screens, virtual reality, voice input, and heads-up displays will minimize computer operator involvement and speed the flow of data between machine and operator. This will help increase the amount of data that can be manipulated and analyzed.

By 2025 intelligent software "agents" will have the capability to search for and filter raw data and analyzed information. Progeny of the web "robots" that currently index the World Wide Web, these agents will roam friendly and enemy information databases in search of the information needed by their "master."⁵³ Also, intelligent agents are

expected to have the capability to learn based on past experience, and modify themselves to give the user the information he needs.

The future tactical internet will be more than just digital communications. By 2025, advanced communications and switching technology will provide a tactical network that is redundant and self-healing. This network will provide the capability for all users to share relevant combat knowledge across the battlespace. This common picture will greatly enhance situational awareness and ensure rapid, clear communication of orders and commander's intent, resulting in a reduction of the confusion, fog, and friction of battle.⁵⁴

Conclusion

The forces of the Army After Next are expected to have unparalleled tactical and operational reach with fires, mobility, speed, and information operations. In addition to enhanced reach, these forces will have an unprecedented ability to influence the battlespace with precision maneuver, information, and fires. The sum of these enhanced capabilities is the knowledge to act and the speed enabling the force to exploit this knowledge.

The technological improvements of the Army After Next will not be a panacea, but a new set of enhanced physical capabilities. In light of these changing conditions, Army leaders should how doctrine should change to maximize these new capabilities.

Chapter 4

Analysis and Evaluation of Doctrine

*"We...have carefully examined the emerging predictions for warfare in 2025 and beyond. We believe that no arm may be more profoundly affected than the Field Artillery, beckoning a revolution in approaches to providing fires."*⁵⁵

Brigadier General Toney Stricklin

Interdependent Fires and Maneuver

Is the Standard Tactical Mission appropriate for interdependent artillery and maneuver Operations? No, given the anticipated capabilities and combat doctrine changes for the Army After Next, the current system of artillery organization for combat explained in Chapter 2 fails to support interdependent fires. The purpose of current doctrine is designed to organize indirect fire support based upon the support relationship to maneuver. This doctrine lacks an adequate mechanism to assign indirect fires assets a mission separate from maneuver elements. In other words, the purpose of current doctrine is not retained in the Army After Next environment so current doctrine must change.

Current Doctrine

Current doctrine already discussed in Chapter 2 is based on the prevalence of armor and infantry in the direct fire fight, with indirect fires serving as a supporting role. In this sense indirect fires are a force multiplier, not a primary combat arms force. With this doctrinal model, "individual fire support assets support forces in contact in various time-tested roles and missions. The field artillery supports forces in contact by performing its traditional roles of close support, counterfire and interdiction."⁵⁶

The traditional paradigm of combat operations is a “find-shape-finish” sequence. In the “find” phase of operations, reconnaissance assets identify enemy formations. Then indirect fires “shape” the enemy forces to set the conditions for the follow-on direct fire fight and to destroy enemy indirect fire assets. Then the maneuver forces close with and conduct the main destruction of the enemy with organic arms and supporting fires.

Army After Next Capabilities & Current Doctrine Shortfalls

By 2025, technological advancements will invalidate the basis on which the current fire support organization for combat doctrine was developed. The basis of future organization doctrine will be that fires can accomplish tasks independent of or interdependent of maneuver forces. This “ascendancy of fires” is a concept central to the Army After Next paradigm. In this quote, General Glenn Otis describes his belief that the relationship between fires and maneuver is shifting toward the ascendancy of fires.

I believe we're at the threshold of major change for the combined arms team - the ascendancy of fires. What that means is that we, as a nation, will fight conventional battles using firepower of all kinds from longer ranges, much of it indirect - not eyeball-to-eyeball using direct fire. We'll use long-range fires as the spearhead of the attack to the extent that the ground maneuver forces may only need to mop up after the fires. That's a totally different concept of operations. This concept aims at achieving decisive results while minimizing the usual high casualties of the direct fire battle.⁵⁷

The implication of the ascendancy of fires is that this concept breaks the paradigm of fires supporting maneuver. The new paradigm raises fires to be “co-equal” with maneuver and capable as a principal means of achieving battlefield objectives.

The emergence of a new fires paradigm was demonstrated in the Division Advanced Warfighting Experiment held in November, 1997. The results show increasing significance of fires on the battlefield. This experiment demonstrated a notable

advantage of placing greater reliance on fires that fundamentally altered the sequence of battle. The experiment demonstrated a battle sequence consisting of “find-kill-finish.” The essential difference from the traditional model was the “kill” phase consisted of massed effects of precision, highly lethal indirect fires on the enemy formation. Here the majority of the enemy forces were destroyed and the enemy force was rendered combat ineffective. Then, in the “finish” phase, maneuver forces destroyed the enemy remnants.⁵⁸

According to the experiment Initial Insights Report “[4th Infantry Division’s] successes point to the potentially decisive impact that Force XXI fires will have on the division’s ability to dominate a larger enemy in an expanded battlespace. A combination of space assets, joint air, attack aviation and field artillery fires played a central role in the division’s dominance of forces over four times its size in each of three successive operations.”⁵⁹

Two fundamental trends supply the technical means for the “ascendancy of fires.” First, unprecedented precision is changing the nature of artillery employment. Significant advances in three areas will empower precision strikes in the Army After Next:

1. Systems will provide extremely accurate, near real-time intelligence to allow precision targeting of enemy forces under all conditions. Improvements in command, control, and communications systems will rapidly transmit required data from intelligence collectors to attack systems to engage the target.

2. Platforms and extended range weapons will deliver munitions to deeper targets than possible today.
3. Smart and brilliant sub-munitions will sense, track and destroy enemy targets under all conditions.⁶⁰

Second, traditional limitations such as a firing signature that makes the unit vulnerable to detection by enemy target acquisition assets and limited ability to destroy armored, moving targets are disappearing.⁶¹ Thanks to brilliant, highly lethal munitions now in production or on the drawing board, future indirect fire will have destructive capabilities similar to flat-trajectory direct fire weapons. In short, decisive indirect fire target effects will no longer require massed guns firing multiple volleys.

These factors will drive a change in tactical doctrine. Future indirect fires employing “ambush-like ‘precision engagements’ using large numbers of precision munitions at once and not sequentially over time will define tactics.”⁶² In many, but not all situations and environments, future fire support may destroy the majority of enemy forces using long range, precision fires, with the maneuver forces only required to “mop-up” afterwards.

In 1991, Operation Desert Storm provided a glimpse of the coming “ascendancy of fires.” One of the innovative uses of field artillery was the artillery task force. The U.S. Marines and Army formed artillery task forces to accomplish certain missions using artillery as the primary means and maneuver forces in a supporting role. In January 1991, the I Marine Expeditionary Force was given the mission to deceive and disrupt Iraqi forces along the Kuwait and Saudi Arabia southwestern border. The Force commander and staff determined that the artillery raid was the best way to accomplish the

mission. The mission force was composed of a general support artillery battalion supported by a Light Armored Infantry Battalion and USAF Close Air Support aircraft. This artillery task force successfully accomplished its assigned missions using field artillery as the primary means to destroy the majority of Iraqi forces.⁶³

The concept of the artillery raid is not new and artillery has always been employed far forward. However, this example of artillery operating not as a support force, but as a combat force supported by ground maneuver and fixed-wing aircraft, shows a glimpse into the future. This type of organization foreshadows a highly lethal future indirect fires force, equipped with precision, armor-killing munitions with the capability to find, attack, and finish the bulk of an enemy force.

Distributed Operations

Army After Next fire support structured using Standard Tactical Missions will not effectively support distributed operations. Significant changes in the fires model will change the conditions that Standard Tactical Missions were developed for. These changes include increased battlefield dispersion, weapons capabilities, command and control. In addition, the transition to effects based doctrine will replace the traditional “weapon-centric” fires doctrine. Standard Tactical Missions will not be relevant in an environment where resources are allocated by effects instead of by platform.

Current Doctrine

Field Artillery doctrine has long emphasized centralized control of fires as the most efficient means to distribute fires. However, limitations in command, communications, and control and in the range, mobility, and versatility of our shooting systems, dictated

positioning firing platforms close to supported maneuver units and use of standard tactical missions.⁶⁴ Army After Next technology will overcome these limitations.

Since the 1800s, commanders have typically allocated field artillery systems to maneuver formations by assigning batteries, battalions, and brigades in a variety of organizational schemes. Figure 4 shows the current organizational model with Direct Support and Reinforcing field artillery battalions aligned with and positioned close to specific maneuver formations. This figure also shows General Support and General Support Reinforcing battalions positioned generally behind the Direct Support units providing support to the whole force.

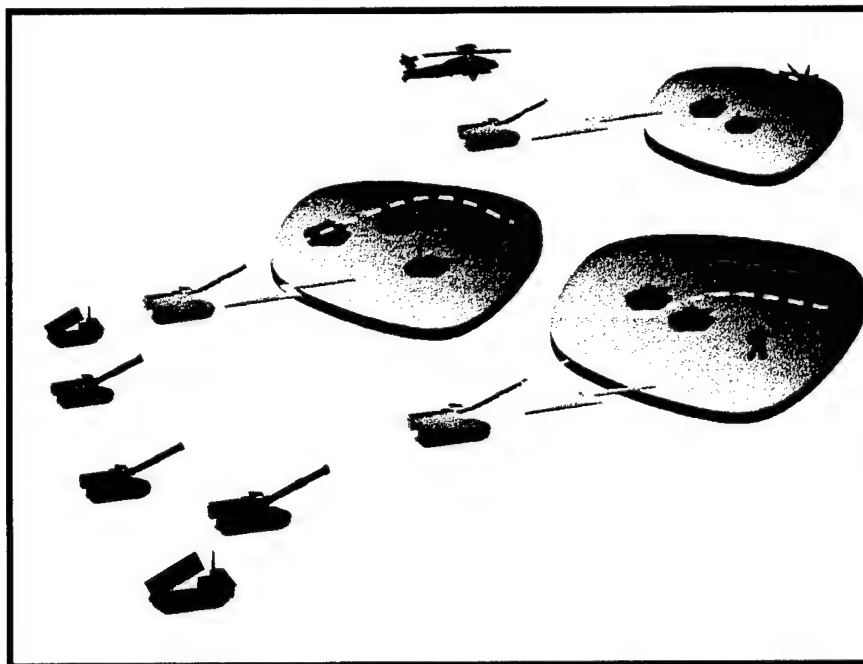


Figure 4. Typical Heavy Division Fire Support Structure

This system was designed for short range, hierarchical command and control restrained by radio and span of control limitations. Here General William H. Hartzog, Commander, Training and Doctrine Command, describes “yesterday’s battlefield”,

Linear, and densely populated with men and equipment, it was divided into a deep, close and rear area. You can see here the division’s battle space dimensions – 100k deep, 80k wide. When we fought, we fought in

linear fashion, massing men and materiel shoulder to shoulder, hub to hub. Our operations were organized on a forward line of troops and forward edge of battle area. Our divisions ground forward consuming the terrain, the enemy, over time.⁶⁵

Generally speaking, these battlefields were relatively linear in nature with combat units typically arrayed in contiguous sectors. Thus the current system was optimized for a relatively linear, industrial age battlefield.

The Vietnam War demonstrated the limitations of the current model for fires organization on a distributed battlefield. When the US applied linear artillery doctrine in the non-linear, dispersed battlefield of Vietnam, it found that the “distinction between reinforcing, general and direct support artillery had often to be disregarded.”⁶⁶

Army After Next Capabilities & Current Doctrine Shortfalls

What will change by 2025 that requires a different fires model? Modern weaponry utilizing highly lethal brilliant munitions will continue the evolution towards widely dispersed and non-contiguous forces on future battlefields.⁶⁷ Figure 5 shows how future battlespace is expected to continue to increase. This will require systems that can support distributed non-linear operations. Army After Next concepts envision future warfare characterized by high tempo operations, with agile battle units operating over large areas.⁶⁸ Other concepts foresee air-mechanized ground combat systems able to maneuver at significantly greater speed and depth than current heavy-armored formations.⁶⁹

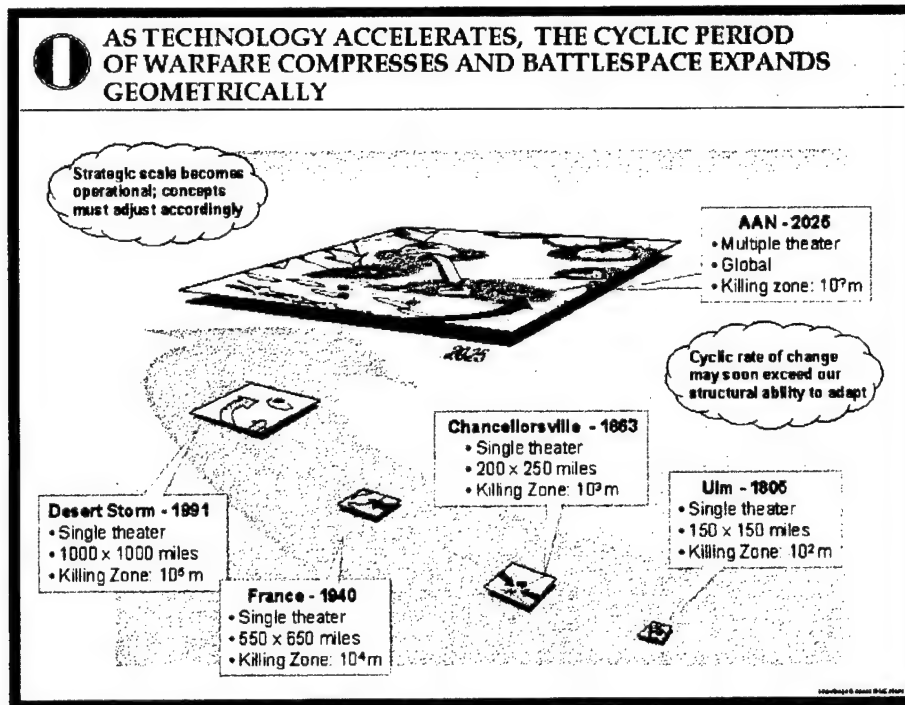


Figure 5. Expanding Battlespace⁷⁰

To support this type of rapid maneuver over long distances will require indirect fires organizations to undergo technological and organizational changes. A second significant change by 2025 will occur in weapons and control systems discussed in detail in Chapter 3. Given this revolutionary fire support and battle command automation, an enhanced capability will exist by 2025 to fluidly position fires platforms to deliver critical fires and effects when and where needed. Future Army and joint weapon systems and munitions will have greatly increased range and span of control which will allow fires platforms to break the current bond with specific maneuver formations. No longer will range and control limitations dictate positioning in the vicinity of maneuver formations.

Another reason fires platforms will not be placed with every maneuver element is a critical tenet of the Army After Next concept, agility. Future deployed combat forces will need to enter a theater and begin decisive operations as quickly as possible. Because of this, much of the future indirect fire support will need to come from platforms not in

theater such as space-based systems, or from dispersed platforms operating in theater but not physically located near maneuver forces, such as Unmanned Aerial Vehicles and long range indirect fires.

In the expanded battlefield and given the smaller size of future combat forces, the Army can no longer simply position assets in the vicinity of every combat element. Even with expanded range capabilities, fire support units will not be able to be placed in direct support and operating within close proximity of every combat maneuver unit.

A fourth change in the environment of 2025 is the transition to an effects based model for fires. According to Major General Leo J. Baxter, Chief of Field Artillery, "We must shift from managing weapons systems to managing fires effects."⁷¹ Brigadier General Toney Stricklin, Assistant Commandant of the Field Artillery School expands on this idea, "Fires effects are critical; the physical location of platforms may be less so. Fires platforms can be positioned to optimize the ability of the total artillery system to apply overmatching effects quickly and decisively when and where needed."⁷² What this means is a fires management and allocation model that distributes fires not by platform, battery, or battalion. Instead, fires are distributed by centralized allocation of munitions resources during specific time periods to produce required effects on the enemy. Using this new model, the standard tactical mission will no longer be applicable.

Figure 6 shows how this future battlefield may look. This figure depicts non-linear distributed battlefield anticipated in future conflict. The figure highlights the absence of Direct Support structured indirect fire platforms aligned with specific maneuver units. This figure also depicts centralized management of fires platforms and munitions dispersing fires across the force as a whole.

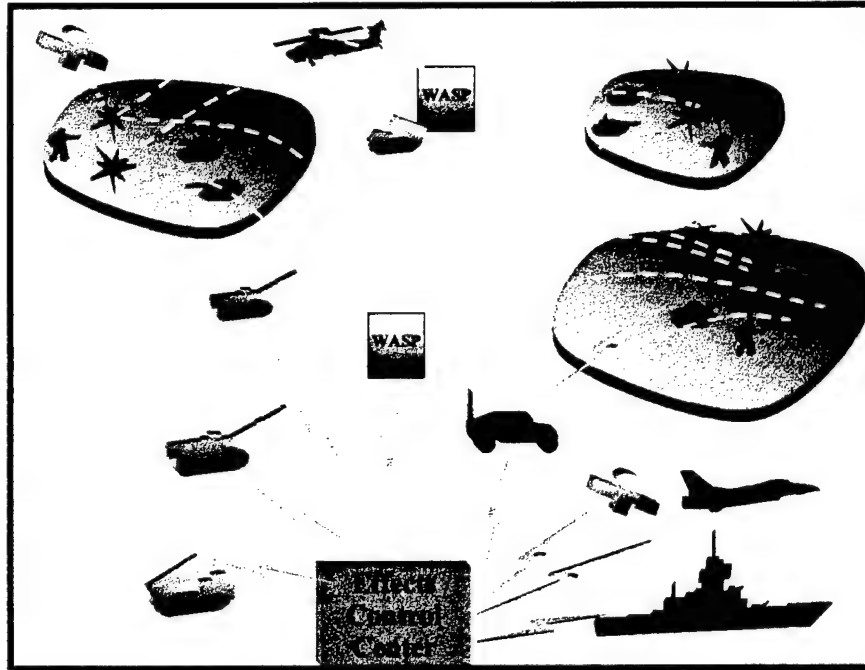


Figure 6. Army After Next Distributed Structure⁷³

Responsiveness & Efficiency

Is Army After Next fire support structured using Standard Tactical Missions responsive to requesting unit's needs or does Standard Tactical Missions handicap fires? No, current doctrine is not simultaneously responsive to both the force commander and maneuver subordinate units. In addition, Standard Tactical Missions prevent utilization of firing platforms at their maximum efficiency because this organization places assets in a hierarchy which "stovepipes" fires requests and coordination. The current organizational structure limits use of fires assets at maximum capacity because of practical difficulties in providing support to units outside of the established hierarchy.

Current Doctrine

As previously explained, Standard Tactical Missions were designed to accommodate an environment of limited communications and control means. Current doctrine cites responsiveness as one of the critical aspects of fire support for fires to be most effective.

The shortfall of current artillery organization for combat doctrine is that the system of assigning Standard Tactical Missions sacrifices centralized control at the expense of subordinate unit responsiveness, or vice-versa. The issue is that the commander must assign missions to make fire support responsive to two different and sometimes conflicting entities. This conflict is inherent in the nature of assigning divergent Standard Tactical Missions of direct or general support.

First, fires must be responsive to the supported combat arms commander. According to Field Manual 6-20, Field artillery support is most responsive to committed maneuver elements when it is placed in direct support.⁷⁴ The force commander may assign a direct support artillery battalion to each committed maneuver brigade to provide immediately available fires virtually dedicated to that brigade.

The second entity that requires responsive fires is the force commander. The commander normally desires fire support assets operating under his direct control and not dedicated to a specific sub-element. This way the commander has fire support assets that are immediately available to him and that he can direct their employment to influence the fight he desires. For example, under current doctrine, the force commander may choose to retain a general support artillery battalion under centralized control and positioned where it can fire throughout the force's area of operations.

Current doctrine allocates resources to support specific units using the direct support or reinforcing mission. It is important to note that these units are not solely dedicated or "reserved" for that unit's use. These fire support units may respond to fire mission requests from other agencies, but at a lower priority than the supported unit. In practice,

however, current command and control systems and range limitations severely restrict support across organizational boundaries.

Another shortfall of the current system is that the current organizational structure limits use of fires assets at maximum capacity because of practical difficulties in providing support to units outside of the established hierarchy. The essence of the problem of organizing fire support around tactical missions is the creation of a hierarchical structure of fire support systems. This organization places artillery at the brigade, division, and corps echelons with a layer of command and control at each echelon. The current system tends to stovepipe fire support requests through a series of request channels that follow linear organizational lines. For example, Figure 8 shows the typical organizational model for a typical heavy division.

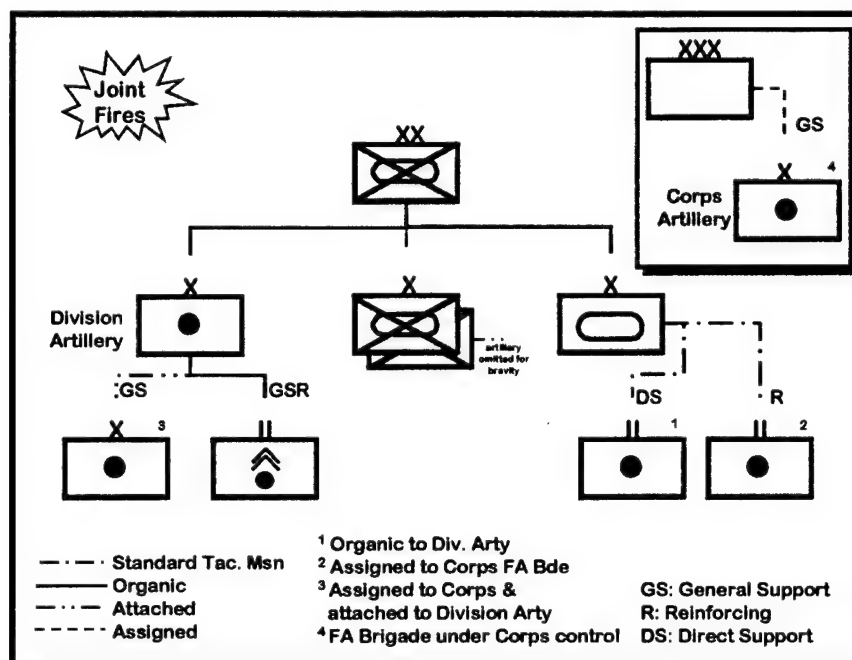


Figure 8. Typical Heavy Division Fire Support Structure

This structure causes delays in fire mission request processing because of the multiple control nodes a request must transit. For example, if a direct support Field

Artillery battalion requires additional fires beyond its capabilities, it must request fires to the next higher echelon, the division, which then directs a divisional general support battalion to fire the mission.

This delay is especially inherent in requests for fire that cross organizational boundaries. For example, if a direct support field artillery battalion requires additional fires and requests assistance from an adjacent brigade then the request must still flow up to the divisional echelon which then tasks the adjacent brigade to fire the mission.

Army After Next

The purpose of current indirect fires organization doctrine will be obsolete by 2025. Communications and control limitations will no longer bind the artillery to its current system of establishing Standard Tactical Missions to meet the needs of the force commander and subordinate maneuver units. Significant increases in the ability of centralized control to satisfactorily provide responsive fires simultaneously to both the force commander and subordinate elements will render the reasons for Standard Tactical Missions obsolete. These enhanced capabilities will not just provide responsive fires to both entities, but will provide incredible flexibility to rapidly change the allocation of effects between the two as necessary to maximize efficiency.

A historical parallel is when field artillery moved to more centralized control after World War II to increase coverage with fewer resources, mass fires quickly and accurately, and to provide flexibility. Field artillery was able to accomplish this move because of leap-ahead communications equipment and control techniques pioneered during World War II.⁷⁵ The Army After Next will also see drastic increases in communications and control capability that will drive a similar shift to increasingly

centralized control. These capabilities will increase to a point that requires a substantial departure from the fires model the U.S. Army has used since World War II.

According to TRADOC Pamphlet 525-5, Force XXI Operations, “advances in information management and distribution will facilitate the horizontal integration of battlefield functions and aid commanders in tailoring forces and arranging them on land. New communications systems allow non hierarchical dissemination of intelligence, targeting, and other data at all levels. This new way of managing forces will alter, if not replace, traditional, hierarchical command structures with new, internetted designs.”⁷⁶

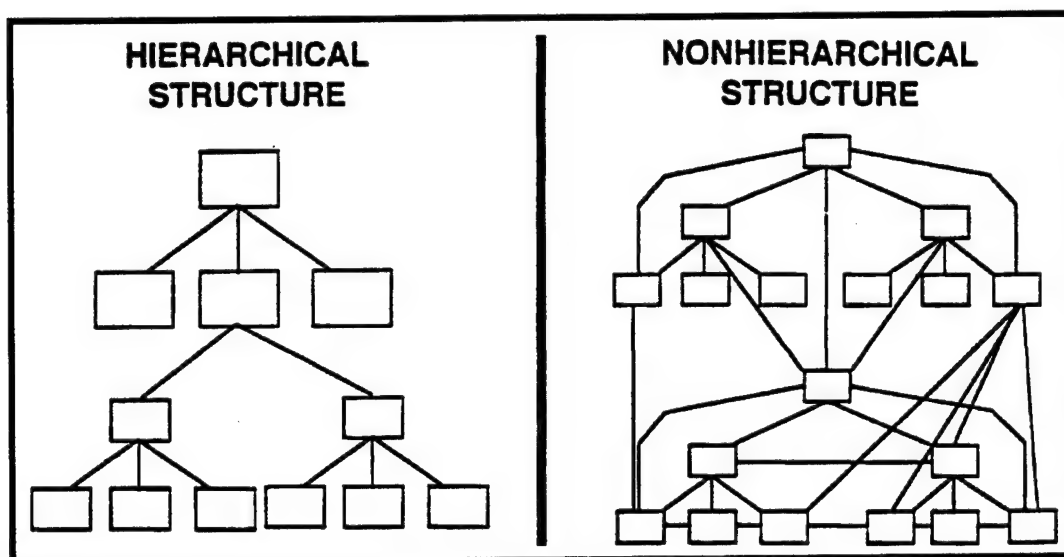


Figure 7. Structure transformation⁷⁷

The Effects Control Center is the implement to break the hierarchical command and control structure used today. The Effects Control Center concept promises to completely re-engineer the basic structure of the fire support command and control system into more of a “matrix” or “internetted” design. According to Brigadier General Toney Stricklin,

In 2025, we must go well beyond the sensor to shooter links we’re working so hard to perfect today. Twenty first century fires will have sensor linkages to a much broader range of on demand effects. Centralized effects management can be realized with the development of

an enhanced capability—an effects control center—linked to a multitude of sensors and effects providers, including space based systems. What we need is an Effects Control Center capable of establishing, altering and terminating direct sensor-to-effects links in seconds without lengthy coordination and reconfiguration.⁷⁸

One critical implication of the Effects Control Center is increased “span of control”.

This will allow the Effects Control Center to control numerous fire support assets that previously required multiple nodes in layered hierarchies to control.

Another benefit of the Effects Control Center is the ability to centrally manage platform and munitions capacity and usage. The Effects Control Center will ensure that that each firing unit is employed at maximum efficiency by centralized distribution of fires tasks. This capability will allow the rapid allocation and reallocation of effects to meet the needs of the force commander, and at the same time provide unprecedented responsiveness to the subordinate maneuver commanders.

Figure 9 illustrates a possible Army After Next battle unit structure. This structure utilizes the Effects Control Center previously mentioned to command and control indirect fires. This structure provides centralized control of fires in a matrix format, which eliminates multiple control nodes at each echelon. This way, fire missions are processed and coordinated much quicker which in turn increases responsiveness to both the battle units and the force commander.

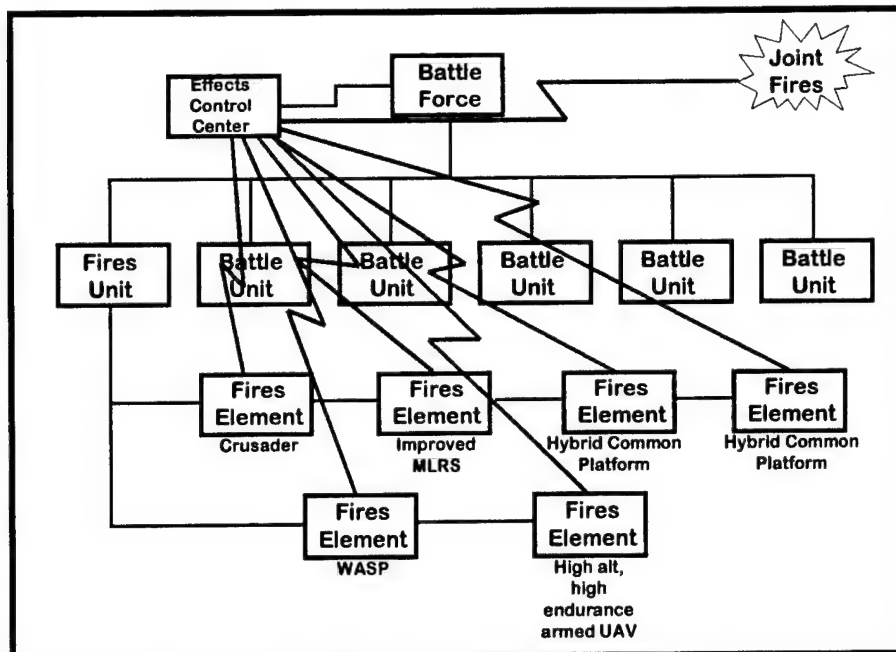


Figure 9. Possible Army After Next Battle Unit Structure⁷⁹

Chapter 5

Conclusion

*"Victory smiles upon those who anticipate the changes in the character of war, not upon those who wait to adapt themselves after the changes occur."*⁸⁰

Giulio Douhet

Army After Next technology will require a change to the Field Artillery Standard Tactical Missions as the means to organize for combat. This conclusion is based on an examination of the concept of Standard Tactical Missions using four criteria: interdependent fires and maneuver, distributed operations, responsiveness, and efficiency. In all four criteria, the use of Standard Tactical Missions in their current form fails to exploit the capabilities inherent in the forthcoming advanced technology. The technological capabilities anticipated by 2025 invalidate the basis on which the current fire support organization for combat doctrine was developed.

The environment of 2025 will exhibit profound changes. U.S. soldiers will have exponential increases in command, control and communications capabilities coupled with lethal, adaptive, and semi-autonomous munitions. Increased weapons lethality and precision munitions will compel distributed operations and the interdependence of fire and maneuver. All of these changes will require fundamental reengineering of current doctrine.

In this environment, Major General Leo Baxter believes "future concepts will deal in terms of allocating fires for specific tasks rather than organizing artillery forces to support specific commands. Future organizations must get beyond the notion of dedicated, organic, and supporting artillery. Rather, we must focus on designing an adaptive force structured to allocate fires to users at multiple levels—simultaneously."⁸¹

Summary of the Findings

This monograph identifies significant changes in the battlefield environment of 2025. The impact of these changes can be summarized by three trends.

- Enhanced command, control, weapon and munitions capabilities will allow indirect fires to shift from “point” coverage to “area” coverage.
- Emphasis will shift from weapons platforms and positioning to munitions centrality and massing effects.
- Shift from decentralized to centralized control without the loss of responsiveness to maneuver unit needs.

Standard Tactical Missions are not appropriate for interdependent artillery and maneuver operations. With the anticipated capabilities and combat doctrine changes for the Army After Next, the current system of artillery organization fails to support interdependent fires. The purpose of current doctrine is designed to organize indirect fire support based upon the support relationship to maneuver. This doctrine lacks an adequate mechanism to assign indirect fires assets a mission separate from maneuver elements. The purpose of current doctrine is not retained in the Army After Next environment so current doctrine must change.

Army After Next indirect fires structured using Standard Tactical Missions will not effectively support distributed operations. Significant changes in the fires model will change the conditions that Standard Tactical Missions were developed for. These changes include increased battlefield dispersion, weapons capabilities, command and control. In addition, the transition to effects based doctrine will replace the traditional “weapon-centric” fires doctrine. Standard Tactical Missions will not be relevant in an environment where resources are allocated by effects instead of by platform.

Army After Next fires organized using Standard Tactical Missions will not be responsive to the total forces needs. This organizational model is not simultaneously responsive to both the force commander and maneuver subordinate units. Besides limited responsiveness, Standard Tactical Missions prevent utilization of firing platforms at their maximum efficiency because this structure places assets in a hierarchy which “stovepipes” fires requests and coordination. The current organizational structure limits use of fires assets at maximum capacity because of practical difficulties in providing support to units outside of the established hierarchy.

Areas of Further Study

One possibility change to doctrine would be to assign a task and purpose for fires to the indirect fires unit instead of a Standard Tactical Mission as currently written. This task and purpose married with a commander’s intent and concept of the operation would be sufficient guidance for the indirect fires unit commander and staff to plan and execute attacks independent of maneuver forces.

Major Norman Brehm examined the concept of the “Mission Oriented Task and Purpose” in a thesis titled “Evolving Field Artillery Standard Tactical Missions for Force XXI.” In this paper, Brehm proposes mission oriented task and purpose statements to potentially replace the Standard Tactical Mission.⁸²

Another area requiring further study is the investigation of how will the blurring of field artillery, direct fire, unmanned aerial vehicles, and space based weapon systems impact of future doctrine? What are the implications of a future weapon system that combines the abilities of the tank with the howitzer? What are the doctrinal implications of such a system can provide both close, direct fires and long-range indirect fires?

A final area of further study would be the impact of the recommended doctrinal changes on indirect fire coordination procedures. The changes brought by enhanced situational awareness and communications capability in a non-hierarchical structure will certainly facilitate rapid clearance of fires using the current system. Further analysis could examine the relevance of current coordination procedures and control measures such as coordinated fire lines.

This study ends with a word of caution. First, the Army must always remember that technology is not a panacea. To implement any of the Army After Next technological solutions requires sound leadership and well-trained soldiers. Second, the Army must not rush to judgement on Army After Next analysis, but must take the time to thoroughly examine all of the possibilities. The Army must not fall into the same trap as the planners of the Pentomic era, whose flying jeeps and rocket infantry never materialized. Technology, training, and doctrine development require sufficient analysis so not to cut corners that could result in disaster. This monograph walked just one path that doctrine might take in the realm of field artillery standard tactical missions.



Endnotes

¹ Sun Tzu, *Art of War*, trans. Ralph D. Sawyer (Boulder, CO.: Westview Press, Inc., 1994), 167.

² John M. Shalikashvili, "Joint Vision 2010: America's Military Preparing for Tomorrow," *Joint Force Quarterly* (Summer 1996), 39.

³ U.S. Army, *The Annual Report on the Army After Next Project to the Chief of Staff of the Army* (Washington, D.C.: U.S. Government Printing Office, July 1997), B-1.

⁴ Ibid., 1.

⁵ U.S. Army, *Field Manual 6-20, Fire Support in the Airland Battle* (Washington, D.C.: U.S. Government Printing Office, 17 May 1988), 2-8.

⁶ Ibid., 2-10.

⁷ Ibid., 2-8.

⁸ U.S. Army, *Field Manual 101-5-1, Operational Terms and Graphics* (Washington, D.C.: U.S. Government Printing Office, 17 May 1988), 1-117. Organic: Assigned to and forming an essential part of a military organization. Organic parts of a unit are those listed in its table of organization for the Army."

⁹ Ibid., 1-13. Assign: To place units or personnel in an organization where such placement is relatively permanent, and/or where such organization controls and administers the units or personnel for the primary function, or greater portion of the functions, of the unit or personnel.

¹⁰ Ibid. Attach: The placement of units or personnel in an organization where such placement is relatively temporary.

¹¹ Ibid., 1-114. OPCON: Transferable command authority that may be exercised by commanders at any echelon at or below the level of combatant command. Operational control is inherent in combatant command (command authority). Operational control may be delegated and is the authority to perform those functions of command over subordinate forces involving organizing and employing commands and forces, assigning tasks, designating objectives, and giving authoritative direction necessary to accomplish the mission. Operation control includes authoritative direction over all aspects of military operations and joint training necessary to accomplish missions assigned to the command. Operational control should be exercised through the commanders of subordinate organizations. Normally this authority is exercised through subordinate joint force commanders and Service and/or functional component commanders. Operational control normally provides full authority to organize commands and forces and to employ those forces as the commander in operational control considers necessary to accomplish assigned missions. Operational control does not, in and of itself, include authoritative direction for logistics or matters of administration, discipline, internal organization, or unit training.

¹² Ibid.

¹³ U.S. Army, *Field Manual 6-20*, 2-8.

¹⁴ Ibid., 2-9.

¹⁵ Ibid., 2-11.

¹⁶ Ibid., 2-9.

¹⁷ Ibid.

¹⁸ Ibid.

¹⁹ Ibid.

²⁰ Ibid., 2-10.

²¹ Ibid.

²² Ibid.

²³ Ibid.

²⁴ Ibid.

²⁵ Ibid., 2-9.

²⁶ Antulio J. Echevarria II, "Tomorrow's Army: the Challenge of Nonlinear Change," *Parameters* (Autumn 1998), 85.

²⁷ U.S. Army, *Army After Next Annual Report*, 17. General William H. Hartzog, Commander, Training and Doctrine Command, sees "simultaneous, independent brigade operations, in-stride targeting, vertical and horizontal connectivity, and operating systems that provide the cohesion and connectivity to what would appear from the outside as a very messy battlefield." "Army of the Future," briefing at the Armaments of the Army of the Future Conference (23 June 1998).

²⁸ Jim Bray, "Knowledge and Speed" (briefing given at Training and Doctrine Command, 21 August 1997), 25. See also Colonel Trevor N. Dupuy "How Lethal?" *Army* (February 1979) pp. 23-27 at p. 24, and *Field Artillery and Fire Power* by J.B.A. Bailey, p. 269.

²⁹ Chairman of the Joint Chiefs of Staff, *Joint Vision 2010* (Washington, D.C.: U.S. Government Printing Office, May 1996), 14.

³⁰ U.S. Army, *Land Combat in the 21st Century* (Washington, D.C.: U.S. Government Printing Office, 17 May 1995), 8.

³¹ Glenn K. Otis, "Ascendancy of Fires," interview by Patricia Hollis. *Field Artillery* (June 1995): 18-19.

³² U.S. Army, *Land Combat*, 8.

³³ Jim Bray, "Beyond Knowledge and Speed" (briefing given at Training and Doctrine Command on 16 September 1998), 17.

³⁴ General Accounting Office, *Army Armored Systems: Meeting Crusader Requirements will be a Technical Challenge* (Washington, D.C.: U.S. Government Printing Office, 6 June 1998), 9.

³⁵ Ibid., 4.

³⁶ Net Resources International, *The Website for Defence Industries - Army: Current*, [on-line] (accessed 11 October 1998); available from <http://www.army-technology.com/projects/mlrs/>; Internet.

³⁷ Leo Baxter, "ATLAS: Close Support for Future Light Forces?" *Field Artillery* (September-October 1998), 3.

³⁸ Jason Robbins, "HIMARS," *Field Artillery* (May-June 1998), 35.

³⁹ Toney Stricklin, "Fires: The Cutting Edge for the 21st Century," *Field Artillery* (May-June 1998), 28.

⁴⁰ Robert Killebrew, "The Army After Next: Defining Future Landpower Challenges," *Army* (February 1998), 26.

⁴¹ Scott Fouse, "The Path to Cutting Edge Fires," briefing at the United States Army Field Artillery Center and School, Directorate of Combat Developments (17 August 1998), 19.

⁴² *Ibid.*, 18.

⁴³ *Ibid.*, 15.

⁴⁴ Ed Stiles, "Fires: The Cutting Edge for the 21st Century," briefing at the United States Army Field Artillery Center and School, Directorate of Combat Developments (4 August 1998), 75.

⁴⁵ Association of the United States Army, "Army Weapons and Equipment," *Army* (October 1998), 249.

⁴⁶ U.S. Army, *Special Text 6-60-30, The Army Tactical Missile System Family of Munitions* (Washington, D.C.: U.S. Government Printing Office, undated), 3.

⁴⁷ U.S. Army, *Army After Next Annual Report*, 24.

⁴⁸ An emerging technology, micro-Unmanned Aerial Vehicles, will provide the Army After Next with a significant tactical surveillance capability using miniaturized vehicles. These micro-Unmanned Aerial Vehicles will be plentiful because of their low-cost, yet survivable due to their small radar, visual, and aural "footprint." Sensor packages on micro-Unmanned Aerial Vehicles could include a video camera, radiation sensor, or chemical sensor. Dale Kuska, "Micro-UAVs Possible in Near Future," *Army Link News* (June 1997), 1-2.

⁴⁹ U.S. Army, *Army After Next Annual Report*, 24.

⁵⁰ David Bennahum, "The United Nations of Iridium," *Wired* (October 1998), 142-143.

⁵¹ Department of Defense, *Department of Defense Military Critical Technologies List* (Washington, D.C.: U.S. Government Printing Office, June 1998), 8-7.

⁵² U.S. Army, *Army Vision 2010* (Washington, D.C.: U.S. Government Printing Office, 1996), 17.

⁵³ Andrew Leonard, "Bots are Hot!" *Wired* (April 1996), 145.

⁵⁴ U.S. Army, *TRADOC Pamphlet 525-5: Force XXI Operations* (Washington, D.C.: U.S. Government Printing Office, 1 August 1994), 3-5.

⁵⁵ Stricklin, "Fires: The Cutting Edge for the 21st Century," 24.

⁵⁶ U.S. Army, *Field Manual 6-20*, 2-8.

⁵⁷ Otis, "Ascendancy of Fires," 18-19. General Otis sees two reasons for the "Ascendancy of Fires." First, is the U.S. forces superior ability to locate enemy forces with precision. Second, is the development and continuous refinement of artillery, precision munitions, and associated systems to such an extent that forces can devote more effort to raining highly accurate fire on the enemy.

⁵⁸ Association of the United States Army, *The Division Advanced Warfighting Experiment: Fire Support Implications Defense Report* (Arlington: Institute of Land Warfare, April 1998), 1-2.

⁵⁹ Ibid., 1.

⁶⁰ U.S. Army, *Weapons Systems* (Washington, D.C.: U.S. Government Printing Office, 1997), 152.

⁶¹ U.S. Army, *Field Manual 6-20*, 2-11.

⁶² Huba Wass de Czege, "Fire Power Insights: Potential and Possible Force Wargaming" (briefing presented to the AAN fires integrated idea team on 11 March 1998).

⁶³ James L. Sachtleben, "Artillery Raids in Southwestern Kuwait," *Field Artillery* (October 1991), 25.

⁶⁴ Stricklin, "Fires: The Cutting Edge for the 21st Century," 25.

⁶⁵ William H. Hartzog, "Army of the Future," briefing at the U.S. Army "Armaments of the Army of the Future" Conference (23 June 1998).

⁶⁶ J.B.A. Bailey, *Field Artillery and Firepower* (Oxford: The Military Press, 1989), 250.

⁶⁷ Bray, "Knowledge and Speed," 25. See also Colonel Trevor N. Dupuy "How Lethal?" *Army* (February 1979) pp. 23-27 at p. 24, and *Field Artillery and Fire Power* by J.B.A. Bailey, p. 269.

⁶⁸ John Matsumura, Randall Steeb, and John Gordon IV, *Assessment of Crusader* (Santa Monica: Rand, 1998), xiii

⁶⁹ Ibid., 37. For further reading on this concept see "Air Mech Strike: Revolution in Maneuver Warfare" by Charles Jarnot in the March-April 1997 edition of *Military Review*.

⁷⁰ Bray, "Knowledge and Speed," 25.

⁷¹ Leo Baxter, "Meeting the Future: State of the Field Artillery 1998," *Field Artillery* (November-December 1998), 1.

⁷² Stricklin, "Fires: The Cutting Edge for the 21st Century," 25.

⁷³ Bray, "Beyond Knowledge and Speed, 17. Stricklin, "Fires: The Cutting Edge for the 21st Century," 25-29.

⁷⁴ U.S. Army, *Field Manual 6-20*, 2-10.

⁷⁵ Bailey, *Field Artillery and Firepower*, 271.

⁷⁶ U.S. Army, *TRADOC Pamphlet 525-5: Force XXI*, 2-8.

⁷⁷ Ibid., 2-9.

⁷⁸ Stricklin, "Fires: The Cutting Edge for the 21st Century," 25.

⁷⁹ Bray, "Beyond Knowledge and Speed," 17. Stricklin, "Fires: The Cutting Edge for the 21st Century," 26-29.

⁸⁰ Giulio Douhet, *The Command of the Air*, trans. Dino Ferrari, (New York: Coward-McCann, 1942; reprint, Washington D.C.: Office of Air Force History, 1988), 30.

⁸¹ Leo J. Baxter, "Field Artillery Vision 2020," *Field Artillery* (December 1994), 11.

⁸² Norman Brehm, "Evolving Field Artillery Standard Tactical Missions for Force XXI," (Fort Leavenworth, Kansas: Command and General Staff College, 1995), 57-62.

⁸³ Bray, "Beyond Knowledge and Speed," 17.

BIBLIOGRAPHY

Articles

- Anderson, Edward G., III. "The Army and Space." *Field Artillery*, May-June 1998, 9.
- Association of the United States Army. "Army Weapons and Equipment." *Army*, October 1998, 237.
- Baxter, Leo J. "ATLAS: Close Support for Future Light Forces?" *Field Artillery*, September-October 1998, 2.
- _____. "Field Artillery Vision 2020." *Field Artillery*, December 1994, 10.
- _____. "Fires of the Future-In the Blink of an Eye." *Field Artillery*, March-April 1998, 2.
- _____. "Meeting the Future: State of the Field Artillery 1998." *Field Artillery*, November-December 1998, 1.
- Bennahum, David, "The United Nations of Iridium." *Wired*, October 1998, 140.
- Buckley, Edward T. Jr., Henry G. Franke, and A. Fenner Milton. "Army After Next Technology: Forging Possibilities Into Reality." *Military Review*, March/April 1998, 25.
- Dupuy, Trevor N. "How Lethal?" *Army*, February 1979, 23.
- Echevarria, Antulio J. II. "Tomorrow's Army: the Challenge of Nonlinear Change." *Parameters*, Autumn 1998, 84.
- Ellis, John A. and Daniel J. McCormick. "AFATDS Future- Fire Support C2 for the Next Generation." *Field Artillery*, March-April 1997, 18.
- Gilbert, Rex L. "The Artillery Combat Team: Providing Versatility for America's Tank Division." *Field Artillery*, April 1993, 32.
- Hester, Henry M. "Digitization in Task Force XXI." *Field Artillery*, September-October 1996, 42.
- Jarnot, Charles. "Air Mech Strike: Revolution in Maneuver Warfare." *Military Review*, March-April 1997, 31.
- Killebrew, Robert. "The Army After Next: Defining Future Landpower Challenges." *Army Magazine*, February 1998, 23.

- _____. "The Army After Next: TRADOC's Crystal Ball Eyes the Service's Shape Beyond Force XXI." *Armed Forces Journal International*, October 1996, 36.
- Kuska, Dale. "Micro-UAVs Possible in Near Future." *Army Link News*, June 1997, 1.
- Leonard, Andrew. "Bots are Hot!" *Wired*, April 1996, 141.
- Net Resources International. *The Website for Defence Industries - Army: Current*. [online] (accessed 11 October 1998); available from <http://www.army-technology.com/projects/mlrs/>; Internet.
- Otis, Glenn K. "Ascendancy of Fires." *Field Artillery*, June 1995, 15.
- Robbins, Jason. "HIMARS." *Field Artillery*, May-June 1998, 35.
- Sachtleben, James L. "Artillery Raids in Southwestern Kuwait." *Field Artillery*, October 1991, 24.
- Seffers, George. "More Power on the Front Lines." *Army Times*, 10 August 1998, 26.
- Shalikashvili, John M. "Joint Vision 2010: America's Military Preparing for Tomorrow." *Joint Force Quarterly*, Summer 1996, 39.
- Stricklin, Toney. "Fires: the Cutting Edge for the 21st Century." *Field Artillery*, May-June 1998, 24.
- Valcourt, David P. "Force XXI Victory More Than Just Gizmos and Digits." *Field Artillery*, May-June 1998, 13.
- Walker, Susan I. "Fires 2020 The Field Artillery Roadmap." *Field Artillery*, March-April 1997, 30.
- Weaver, Vince C., Jr. "Fires in AWE Focused Dispatch- A Step Toward Task Force XXI." *Field Artillery*, March-April 1996, 50.
- Yagar, John K. and Jeffrey L. Froysland. "Improving the Effects of Fires with Precision Munitions." *Field Artillery*, March-April 1997, 5.

Books

- Association of the United States Army. *The Division Advanced Warfighting Experiment: Fire Support Implications Defense Report*. Arlington: Institute of Land Warfare, 1998.

- Bailey, J. B. A. *Field Artillery and Firepower*. Oxford: The Military Press, 1989.
- Bishop, H. G. *Field Artillery The King of Battles*. Cambridge: The Riverside Press, 1935.
- Cohen, Eliot A. and John Gooch. *Military Misfortunes, The Anatomy of Failure in War*. New York: The Free Press, 1990.
- Dastrup, Boyd L. *The Field Artillery, History and Sourcebook*. Westport, Connecticut: Greenwood Press, 1994.
- Douhet, Giulio. *The Command of the Air*, trans. Dino Ferrari. New York: Coward-McCann, 1942; reprint, Washington D.C.: Office of Air Force History, 1988.
- Dubik, James M and Gordon R. Sullivan. *Envisioning Future Warfare*. Fort Leavenworth, Kansas: U.S. Army Command and General Staff College Press, 1995.
- Matsumura, John M., Randall Steeb, and John Gordon IV. *Assessment of Crusader*. Santa Monica: Rand, 1998.
- Staff of the Field Artillery Journal. *Field Artillery Guide*. Washington, D.C.: U.S. Field Artillery Association, 1942.
- Sullivan, Gordon R. *America's Army Into the Twenty-First Century*. Hollis, New Hampshire: Puritan Press Inc., 1994.
- Sun Tzu. *Art of War*. Translated by Ralph D. Sawyer. Boulder: Westview Press, 1994.

Briefings

- Bray, Jim. "Knowledge and Speed." Briefing given at U.S. Army Training and Doctrine Command, 21 August 1997.
- _____. "Beyond Knowledge and Speed." Briefing given at U.S. Army Training and Doctrine Command, 16 September 1998.
- Fouse, Scott. "The Path to Cutting Edge Fires." Briefing given at the United States field Artillery Center and School, Directorate of Combat Developments, 17 August 1998.
- Hartzog, William H. "Army of the Future." Briefing given at the Armaments of the Army of the Future Conference, 23 June 1998.

Stiles, Ed. "Fires: The Cutting Edge for the 21st Century." Briefing given at the United States field Artillery Center and School, Directorate of Combat Developments, 4 August 1998.

Wass de Czege, Huba. "Fire Power Insights: Potential and Possible Force Wargaming." Briefing presented to the Army After Next fires integrated idea team, 11 March 1998.

Monographs and Theses

Brehm, Norman. "Evolving Field Artillery Standard Tactical Missions for Force XXI." Command and General Staff College, 1995.

Carey, Mark G. "Forging Apollo's Golden Bow: Long Range Precision Fires in Future High Intensity Combat." School of Advanced Military Studies, 4 December 1996.

Smith, John T. "Precision Warfare Enables Interdependent Fires and Maneuver in 2010." School of Advanced Military Studies, 18 December 1997.

U.S. Government Publications

Dastrup, Boyd L. *King of Battle*. Washington, DC: US Government Printing Office, 1993.

Chairman of the Joint Chiefs of Staff. *Joint Vision 2010*. Washington, DC: The Joint Staff, 1996.

Department of Defense, *Department of Defense Military Critical Technologies List*. Washington DC: US Government Printing Office, 1998.

General Accounting Office. *Army Armored Systems: Meeting Crusader Requirements will be a Technical Challenge*. Washington DC: US Government Printing Office, 1997.

U.S. Army. *The Annual Report on the Army After Next Project to the Chief of Staff of the Army*. Washington, DC: US Government Printing Office, 1997.

_____. *Army Vision 2010*. Washington, DC: US Government Printing Office, 1996.

_____. *Field Manual 6-20: Fire Support in the Airland Battle*. Washington DC: US Government Printing Office, 1988.

- _____. *Field Manual 6-20-1: The Field Artillery Cannon Battalion*. Washington DC: US Government Printing Office, 1990.
- _____. *Field Manual 6-20-2: Corps Artillery, Division Artillery, and Field Artillery Brigade Headquarters*. Washington DC: US Government Printing Office, 1993.
- _____. *Field Manual 6-20-30: Fire Support for Corps and Division Operations*. Washington DC: US Government Printing Office, 1989.
- _____. *Field Manual 100-5: Operations*. Washington DC: US Government Printing Office, 1993.
- _____. *Field Manual 100-5 (Revised Final Draft): Operations*. Washington DC: US Government Printing Office, 1998.
- _____. *Field Manual 101-5-1: Operational Terms and Graphics*. Washington DC: US Government Printing Office, 1997.
- _____. *Land Combat in the 21st Century*. Washington DC: US Government Printing Office, 1995.
- _____. *Special Text 6-60-3: The Army Tactical Missile System Family of Munitions*. Washington, D.C.: U.S. Government Printing Office, undated.
- _____. *Training and Doctrine Command Pamphlet 525-5: Force XXI Operations*. Washington, DC: US Government Printing Office, 1994.
- _____. *Training and Doctrine Command Pamphlet 525-200: Depth and Simultaneous Attack*. Washington, DC: US Government Printing Office, 1994.
- _____. *Weapons Systems*. Washington, D.C.: U.S. Government Printing Office, 1997.